WHAT IS CLAIMED IS:

1. A portable radio system employing an automatic frequency control for detecting a frequency shift of an internal oscillator of a portable radio equipment with reference to a received wave transmitted from a base station having higher precision of frequency and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator,

wherein coordinate rotation digital computation (CORDIC) is employed for calculation of arctangent in said automatic frequency control.

2. A portable radio system as set forth in claim 1, wherein, upon calculation of arctangent, calculation is performed within a range of $\pm\pi$.

3. A portable radio system as set forth in claim 1, wherein, upon performing calculation of said frequency shift, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi * -1.0

phase = $\pi/2$

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = $-(\pi/2)$

is performed.

4. A portable radio system as set forth in claim 1, wherein, upon performing calculation of said frequency shift, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = $-\pi$

is performed.

5. A portable radio system employing an automatic frequency control for detecting a frequency shift of an internal oscillator of a portable radio equipment with reference to a received wave transmitted from a base station having higher precision of frequency and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, wherein said portable radio equipment comprires;

calculating means for calculating a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;

frequency shift calculating means for calculating a frequency shift of said internal oscillator by dividing said phase difference derived by said calculating means by an interval

of said two symbols; and

control means for controlling for widening said interval when said phase difference derived by said calculating means is smaller than a predetermined set value and for narrowing said interval when said phase difference is greater than said set value.

6. A portable radio system as set forth in claim 5, wherein said two symbols are the same phase when a frequency of said internal oscillator is correct, and

said calculating means derives a phase difference of said two symbols by multiplying one of said two symbols by a complex conjugate of another symbol.

7. A portable radio system as set forth in claim 5, wherein upon calculation of arctangent by employing coordinate rotation digital computation (CORDIC), said frequency shift calculating means performs calculation within a range of $\pm\pi$

8. A portable radio system as set forth in claim 7, wherein, upon performing calculation of said frequency shift, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation,

when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi * -1.0

phase = $\pi/2$

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = $-(\pi/2)$

is performed.

9. A portable radio system as set forth in claim 7, wherein, upon performing calculation of said frequency shift, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate

rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = $-\pi$

is performed.

10. A portable radio system as set forth in claim 5, wherein said control means sets said interval at a predetermined minimum value when out of synchronization is detected at least from failure of decoding or non-detection of pilot and not reaching of power to a predetermined level.

11. A portable radio system employing an automatic frequency control for detecting a frequency shift of an internal oscillator of a portable radio equipment with reference to a received wave transmitted from a base station having higher precision of

frequency and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, wherein said portable radio equipment comprises:

calculating means for calculating a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;

frequency shift calculating means for calculating a frequency shift of said internal oscillator by dividing said phase difference derived by said calculating means by an interval of said two symbols; and

control means for controlling for widening said interval when a value of said frequency shift derived by said frequency shift calculating means is smaller than a predetermined value and for narrowing said interval when said value of said frequency shift is greater than said predetermined value.

Sub A1

12. A portable radio system as set forth in claim 12, wherein said two symbols are the same phase when a frequency of said internal oscillator is correct, and

said calculating means derives a phase difference of said two symbols by multiplying one of said two symbols by a complex conjugate of another symbol.

13. A portable radio system as set forth in claim 12, wherein upon calculation of arctangent of coordinate rotation digital

computation (CORDIC), said frequency shift calculating means performs calculation within a range of $\pm\pi$.

14. A portable radio system as set forth in claim 13, wherein, upon performing calculation of said frequency shift, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0
CORDICi = CORDICq
CORDICq = CORDICi * -1.0
phase = $\pi/2$

when CORDICi < 0.0 and CORDICq < 0.0,
CORDICi = CORDICq * -1.0
CORDICq = CORDICi
phase = $-(\pi/2)$

is performed.

15. A portable radio system as set forth in claim 13, wherein, upon performing calculation of said frequency shift, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = $-\pi$

is performed.

16. A portable radio system as set forth in claim 11, wherein

said control means sets said interval at a predetermined minimum value when out of synchronization is detected at least from failure of decoding or non-detection of pilot and not reaching of power to a predetermined level.

17. A portable radio equipment employing an automatic frequency control for detecting a frequency shift of an internal oscillator of own portable radio equipment with reference to a received wave transmitted from a base station having higher precision of frequency and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator,

wherein coordinate rotation digital computation (CORDIC) is employed for calculation of arctangent in said automatic frequency control.

18. A portable radio equipment as set forth in claim 17, wherein, upon calculation of arctangent, calculation is performed within a range of $\pm\pi$.

19. A portable radio equipment as set forth in claim 17, wherein, upon performing calculation of said frequency shift, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in

calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi * -1.0

phase = $\pi/2$

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = $-(\pi/2)$

is performed.

20. A portable radio equipment as set forth in claim 17, wherein, upon performing calculation of said frequency shift, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles

per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0
CORDICi = CORDICi * -1
CORDICq = CORDICq * -1
phase = π

when CORDICi < 0.0 and CORDICq < 0.0,
CORDICi = CORDICi * -1
CORDICq = CORDICq * -1
phase = $-\pi$

is performed.

~~21~~. A portable radio equipment employing an automatic frequency control for detecting a frequency shift of an internal oscillator of own portable radio equipment with reference to a received wave transmitted from a base station having higher precision of frequency and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, comprising:

calculating means for calculating a phase difference of two symbols taken from a known data modulated by said base station

on the basis of a timing generated by said internal oscillator;

frequency shift calculating means for calculating a frequency shift of said internal oscillator by dividing said phase difference derived by said calculating means by an interval of said two symbols; and

control means for controlling for widening said interval when said phase difference derived by said calculating means is smaller than a predetermined set value and for narrowing said interval when said phase difference is greater than said set value.

22. A portable radio equipment as set forth in claim 21, wherein said two symbols are the same phase when a frequency of said internal oscillator is correct, and

said calculating means derives a phase difference of said two symbols by multiplying one of said two symbols by a complex conjugate of another symbol.

23. A portable radio equipment as set forth in claim 22, wherein upon calculation of arctangent by employing coordinate rotation digital computation, said frequency shift calculating means performs calculation within a range of $\pm\pi$.

24. A portable radio equipment as set forth in claim 23, wherein, upon performing calculation of said frequency shift, parameters

CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi * -1.0

phase = $\pi/2$

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = $-(\pi/2)$

is performed.

25. A portable radio equipment as set forth in claim 23, wherein, upon performing calculation of said frequency shift, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal

to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = $-\pi$

is performed.

26. A portable radio equipment as set forth in claim 21, wherein said control means sets said interval at a predetermined minimum value when out of synchronization is detected at least from failure of decoding of non-detection of pilot and not reaching of power to a predetermined level.

27. A portable radio equipment employing an automatic frequency control for detecting a frequency shift of an internal oscillator of own portable radio equipment with reference to a received wave transmitted from a base station having higher precision of frequency and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, comprising:

calculating means for calculating a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;

frequency shift calculating means for calculating a frequency shift of said internal oscillator by dividing said phase difference derived by said calculating means by an interval of said two symbols; and

control means for controlling for widening said interval when a value of said frequency shift derived by said frequency shift calculating means is smaller than a predetermined value and for narrowing said interval when said value of said frequency shift is greater than said predetermined value.

28. A portable radio equipment as set forth in claim 27, wherein said two symbols are the same phase when a frequency of said internal oscillator is correct, and

said calculating means derives a phase difference of said two symbols by multiplying one of said two symbols by a complex

conjugate of another symbol.

29. A portable radio equipment as set forth in claim 27, wherein upon calculation of arctangent by employing coordinate rotation digital computation, said frequency shift calculating means performs calculation within a range of $\pm\pi$

30. A portable radio equipment as set forth in claim 29, wherein, upon performing calculation of said frequency shift, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi * -1.0

phase = $\pi/2$

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = $-(\pi/2)$

is performed.

31. A portable radio equipment as set forth in claim 29, wherein, upon performing calculation of said frequency shift, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = $-\pi$

is performed.

32. A portable radio equipment as set forth in claim 27, wherein said control means sets said interval at a predetermined minimum value when out of synchronization is detected at least from failure of decoding or non-detection of pilot and not reaching of power to a predetermined level.

33. A frequency error predicting method employing an automatic frequency control for detecting a frequency shift of an internal oscillator of portable radio equipment with reference to a received wave transmitted from a base station having higher precision of frequency and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator,

wherein coordinate rotation digital computation (CORDIC) is employed for calculation of arctangent in said automatic frequency control.

34. A frequency error predicting method as set forth in claim 33, wherein, upon calculation of arctangent, calculation is performed within a range of $\pm\pi$.

35. A frequency error predicting method as set forth in claim

34, wherein, upon performing calculation of said frequency shift, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi * -1.0

phase = $\pi/2$

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = $-(\pi/2)$

is performed.

36. A frequency error predicting method as set forth in claim 34, wherein, upon performing calculation of said frequency shift,

parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = $-\pi$

is performed.

Sub B1 ~~37.~~ A portable radio system employing an automatic frequency control for detecting a frequency shift of an internal oscillator of portable radio equipment with reference to a received wave

transmitted from a base station having higher precision of frequency and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, comprising of steps of:

calculating a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;

calculating a frequency shift of said internal oscillator by dividing said phase difference derived by said calculating step by an interval of said two symbols; and

controlling for widening said interval when said phase difference derived by said phase difference calculating step is smaller than a predetermined set value and for narrowing said interval when said phase difference is greater than said set value.

38. A portable radio system as set forth in claim 37, wherein said two symbols are the same phase when a frequency of said internal oscillator is correct, and

said phase difference calculating step derives a phase difference of said two symbols by multiplying one of said two symbols by a complex conjugate of another symbol.

39. A frequency error predicting method as set forth in claim 37, wherein upon calculation of arctangent of coordinate

rotation digital computation, said frequency shift calculating step performs calculation within a range of $\pm\pi$.

40. A frequency error predicting method as set forth in claim 39, wherein, upon performing calculation of said frequency shift, in said frequency shift calculating step, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi * -1.0

phase = $\pi/2$

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = $-(\pi/2)$

is performed.

41. A frequency error predicting method as set forth in claim 39, wherein, upon performing calculation of said frequency shift, in said frequency shift calculating step, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = $-\pi$

is performed.

42. A frequency error predicting method as set forth in claim 37, wherein said interval controlling step sets said interval at a predetermined minimum value when out of synchronization is detected at least from failure of decoding or non-detection of pilot and not reaching of power to a predetermined level.

43. A frequency error predicting method employing an automatic frequency control for detecting a frequency shift of an internal oscillator of portable radio equipment with reference to a received wave transmitted from a base station having higher precision of frequency and adjusting the frequency of said internal oscillator by feeding back said frequency shift to said internal oscillator, comprising the steps of:

calculating a phase difference of two symbols taken from a known data modulated by said base station on the basis of a timing generated by said internal oscillator;

calculating a frequency shift of said internal oscillator by dividing said phase difference derived by said calculating step by an interval of said two symbols; and

controlling for widening said interval when a value of said frequency shift derived by said frequency shift calculating step is smaller than a predetermined value and for narrowing said interval when said value of said frequency shift is greater than said predetermined value.

44. A frequency error predicting method as set forth in claim 43, wherein said two symbols are the same phase when a frequency of said internal oscillator is correct, and

said phase difference calculating step derives a phase difference of said two symbols by multiplying one of said two symbols by a complex conjugate of another symbol.

45. A frequency error predicting method as set forth in claim 43, wherein upon calculation of arctangent of coordinate rotation digital computation, said frequency shift calculating step performs calculation within a range of $\pm\pi$

46. A frequency error predicting method as set forth in claim 45, wherein, upon performing calculation of said frequency shift, in said frequency shift calculating step, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICq

CORDICq = CORDICi * -1.0

phase = $\pi/2$

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICq * -1.0

CORDICq = CORDICi

phase = $-(\pi/2)$

is performed.

47. A frequency error predicting method as set forth in claim 45, wherein, upon performing calculation of said frequency shift, in said frequency shift calculating step, parameters CORDICi and CORDICq are derived by using a calculation of said coordinate rotation digital computation by replacing the signal to be calculated the phase with I and Q components, and in calculation of said coordinate rotation digital computation, when a parameter for outputting a final angle by adding angles per taps is set as phase, in former stage of said coordinate rotation digital computation, a process expressed by:

when CORDICi < 0.0 and CORDICq > 0.0

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = π

when CORDICi < 0.0 and CORDICq < 0.0,

CORDICi = CORDICi * -1

CORDICq = CORDICq * -1

phase = $-\pi$

is performed.

48. A frequency error predicting method as set forth in claim 43, wherein said interval controlling step sets said interval at a predetermined minimum value when out of synchronization is detected at least from failure of decoding or non-detection of pilot and not reaching of power to a predetermined level.